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ABSTRACT

The final work of the National Skill Standards Development Project (NSSDP) is to create a model for developing and administering a certification program for electronics technicians based on already developed skill standards. During its first 2 years, NSSDP has developed over 300 standards for work-ready, entry-level electronics technicians; developed measurement criteria to assess skill mastery; and determined the need for a program to assess the skill-based competency of entry-level technicians. The model certification program describes a structure and process to create, validate, administer, and protect the test and to record test results. Two tests have been structured--a technical skill exam and a technical fundamentals exam. Proposals from testing organizations for contract support in developing a test bank or pool and test forms are being reviewed. The test administration process includes these components: registration of examinees and verification of registrants; establishment of test sites and appointment of proctors; development and distribution of test guides; onsite test administration; test scoring; and securing of tests and results. Issues of data management related to scoring and security have been covered. Three options for program management are being considered: management by an existing industry organization, establishment of an independent test management organization, and assumption of program management by an existing independent organization. (YLB)

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ED 396 132

*The Electronic Industries Foundation*
*and*
*The Electronic Industries Association*

**NATIONAL SKILL STANDARDS DEVELOPMENT PROJECT**

# FINAL REPORT

## Certification Testing Program for Entry-Level Electronics Technician Skills

*Submitted to:*

**U.S. Department of Education**
Office of Vocational and Adult Education
Business and Education Standards Program
Award No. V244A20012

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**Certification Testing Program**
**for**
**Entry-Level Electronics Technician Skills**
**(National Skill Standards Development Project Final Report)**

## I. INTRODUCTION

### A. PHASE I

The National Skill Standards Development Project (NSSDP) is a 3-year two-phased program funded by the U.S. Department of Education's Business and Education Standards Program Initiative. In Phase I, the Electronic Industries Foundation (EIF) and its parent organization, the Electronic Industries Association (EIA), developed consistent industry-based voluntary national skill standards to improve the competency achieved by work-ready, entry-level electronics technicians. Over 200 individuals representing over 100 electronics companies; government; and national business, labor, and education associations and institutions joined in this effort. Their participation was channeled through service on one or more of the following bodies:

- **Executive Advisory Board** of senior executives, who provided oversight and guidance to the project;
- **Technical Committee** of mid-level managers, who had direct responsibility for developing the skill standards; and
- ***Ad Hoc* Groups** of technicians and their supervisors, who identified skills and developed details for the standards.
- **Focus Groups** of technicians, managers, trainers, and educators, who provided their perspectives on the need for and appropriate content of skill standards.

The standards — over 300 in all — are the industry's definitive statement of its requirements for work-ready technicians capable of entry-level work in any of 11 electronics specialty occupations: general electronics, avionics, business machine service, consumer product service, biomedicine, microcomputer systems, microcomputer systems field service, industrial electronics, instrumentation, telecommunications, and automobile service.

Following their development, they were validated against workplace performance and against standards set by the U.S. Department of Labor's Secretary's Commission on Necessary Skills (SCANS) and reviewed to assure against bias as to race, sex, or ethnicity. They were compared against international benchmarks to assure that U.S. workers would be able to meet standards set anywhere in the world. The final standards were approved by the project's Executive Advisory Board and ratified by the EIA Board of Governors.

The ratified standards were published in manual form in June 1994 as *Raising the Standard, Electronic Technician Skills for Today and Tomorrow* and, as such, were distributed to over 3,100 industry and education users and to state directors of vocational technical education; the latter were asked to duplicate and distribute the manual within their states and territories.

**B. PHASE II**

Phase II had two major objectives. The first was to develop measurement criteria by which to assess mastery of the skills by entry-level electronics technicians. The criteria were developed from original work performed under contract by the Vocational-Technical Education Consortium of States (V-TECS) and reviewed and modified by five *ad hoc* working groups of technicians, educators, and supervisors and by the project's Technical Committee. As completed, three or more criteria were identified for each skill standard, some with subsections; each set of criteria included the expected results of mastery of that skill. The resulting large volume of information led the project to produce the measurement criteria on a 3-1/2" PC-compatible disk with the criteria divided into five files keyed to the sections and numbering used in the manual. The disk was named *Characteristics of Competency, Measurement Criteria for Entry-Level Electronics Technician Skills* and packaged with a cover letter explaining use of the measurement criteria with the standards. The packets were completed in October 1995, distributed to the recipients of *Raising the Standard*, and publicized in magazines and through EIA's World Wide Web site.

The second Phase II objective was to determine whether industry and electronics educators wanted and needed a program to assess the skill-based competency of entry-level technicians and, based on an agreement of need, to develop a plan for implementing such a program.

The project conducted extensive research toward that objective: Focus groups of educators, working technicians, supervisors of technicians, service providers in the research and development, manufacturing, and service sectors, and state directors of vocational technical education provided their perspectives on the importance of accreditation of training programs, the certification of entry-level technicians, or a combination of both assessment options. A literature review and a study of nine accreditation and certification programs operated by and for professional and trade organizations created a body of information on program components and costs and identified best practices that might be incorporated into a program for the NSSDP skill standards. A questionnaire was developed, distributed, and

analyzed to obtain industry input on the content, acceptability, and desirability of accreditation and certification programs.

Based on information gathered by these studies, four assessment scenarios (describing accreditation, certification, and work and education portfolios) were developed and described in another questionnaire distributed to managers and supervisors throughout the industry to identify the industry's preferences. Respondents clearly agreed that assessment of the competency of entry-level technicians is important to the industry. They declared a clear-cut preference for a certification exam for individual technicians based on the skill standards.

As a final step to assure that certification would meet industry needs, the project surveyed a representative sample of corporate human relations managers industry-wide. Their responses clearly indicated that they would view certification as a benchmark in determining qualifications for hiring; that they wanted EIA and EIF to sponsor such a testing program to assure its integrity and its links to the skill standards; and that access to a list of certified individuals would help them identify qualified candidates.

The remainder of this report completes the final work of the NSSDP: creation of a model for developing and administering such a certification program.

## II. A MODEL CERTIFICATION TESTING PROGRAM

This model certification program, developed following over 2 years of research and analysis, describes a structure and process to create, validate, administer, and protect the test and to record test results. All sections describe the model as if it had been adopted for use ("The test will . . . " rather than "The test would . . ."). The structure contains four major tasks: development of the test itself, development of a process for administering the test, development of a data management system, and development of a system for managing the program. The report concludes with a brief discussion of the importance of a comprehensive marketing program to the success of the certification program.

### A. TEST DEVELOPMENT

#### 1. Development and Maintenance of Skill Standards

In order to be valued, any certification test must be based on a body of knowledge that the community of users (in this case, educators, technicians, and electronics industry employers) agrees is important. This step has been accomplished with the development and distribution of the national skill standards for entry-level electronics technicians and corresponding measurement criteria described in the introduction to this report. They are the industry's definitive statement of its requirements for work-ready technicians and have been accepted by industry and education alike.

However, industry requirements change continually as new technologies are introduced. It is expected that the skill standards and corresponding measurement criteria will be updated periodically to reflect these changes, most likely on a 5-year cycle or as technological changes dictate. Successive generations of the test will incorporate these updates to assure that the test continues to reflect industry needs.

### 2. Determination of the Test Structure

In meetings with three groups of supervisors of technicians, through questionnaire responses, and in focus group sessions, industry expressed its overriding need for a scoring system that will give them a profile of the technician's discrete capabilities in specific technical skill areas. That is, they asked for a test that will enable them to determine if a candidate's strengths meet their specific hiring needs. Supervisors preferred a performance-based test to a paper and pencil test and expressed the need for some measurement of the candidate's computer literacy and knowledge of the fundamentals of technical communications and technical math.

To best meet these identified needs, two tests have been structured — a Technical Skills Exam and a Technical Fundamentals Exam (See Figure 1). The former, covering six technical areas, will take 3 to 4 hours to complete; the latter, encompassing three fundamental areas, about 90 minutes. A simulation program such as the Electronic Work Bench or Electronic Test Bench will substitute for performance testing in at least the test equipment and troubleshooting section. The other sections most likely will be paper and pencil tests. Simulation testing will eliminate the high costs of training evaluators to obtain consistent results and uniform performance at test sites across the country. Examinees will be given individual pass/fail scores for each of the six technical areas as well as overall pass/fail scores for the Technical Skills Exam and the Technical Fundamentals Exam.

### 3. Development of the Test Question Bank and Test Forms

EIF/EIA is reviewing proposals from testing organizations (e.g., ATC, ETS, etc.) for contract support in developing a "bank" or "pool" of test questions and an initial set of test forms. All work performed by the contractor selected will be done under supervision of the project manager. The contract group will review the test structures described in the preceding section and, with project staff, select a final structure. *Ad hoc* teams of technicians, supervisors, and educators will actually write the test questions, working from the skill standards and measurement criteria. The contractor will determine the number and length of writing sessions needed and the types and numbers of participants, identify sites and dates for the sessions, and lead the test writing sessions. Three to five questions will be written to cover each discrete skill and piece of fundamental knowledge to be tested. This redundancy in the test question bank makes it possible to develop numerous test forms that produce the same scoring results and responds to security issues covered later in the report.

The contractor will edit the questions for clarity, accuracy, specificity (only one acceptable answer), and lack of bias. The Technical Committee will review and provide comment, based on which the contractor will create a draft bank of test questions that will be validated for use in developing individual certification tests.

In developing different test forms from the approved and validated bank of test questions, the contractor will select among the questions covering like material, make sure that questions for each form cover the same technical content at the same depth and that they are weighted equally and are of equal merit and difficulty. The number of forms also can be increased by putting the same questions in different order to invalidate cheating. After test forms have been administered, they will be compared and equated for uniform grading. For example, if one form produces consistently lower scores than others, the scores would be equated or normalized to be comparable to the others and the test form would be withdrawn and revised.

Industrial certification tests often are named for the outcome, and a similar approach will be taken for the certification test for entry-level electronics technicians. Possibilities suggested to date include Basic Electronics Technician (BET), Qualified Electronics Technician (QET), and Excellence in Electronics (EIE).

#### 4. Validation of the Test

A valid test contains questions unambiguous and unbiased in their presentation; produces consistent, repeatable results; and provides a true differentiation between qualified and unqualified candidate test takers. The contractor will conduct sophisticated field testing to determine that the test meets these criteria. Still working with the project manager, the contractor will design the validation process and establish the pass/fail cutoff points for scoring; identify the number of validation sites needed and the types and numbers of people to take the field tests to provide the necessary results; provide staff to administer and proctor validation tests at selected sites; score and evaluate test results; analyze the results and submit a summary of findings to the project manager; and submit to the project manager a final report documenting the validation process, results, and recommendations. EIF will arrange for actual test sites and individuals to take the tests.

### B. TEST ADMINISTRATION

Once the certification test is developed, a process must be constructed for administering the test. Components of this process will include systems for registration of examinees and verification of registrants; establishment of test sites and appointment of proctors; development and distribution of test guides and other materials; onsite administration of the test itself; scoring the tests; and securing the tests and test results. The process has been developed based upon the experiences and comments of the nine organizations studied and on a review of the published literature.

### 1. Test Registration and Verification

To identify and track individuals wishing to take the exam, the following systems will be developed: an application/registration form including demographic information about the test taker; a method for distributing registration forms in response to direct requests and through publications, educational institutions, and worksites; advanced registration so that program managers will know how many people will be taking each administration of the test, who they are, and which test sites they will use; a means of verifying that the person actually taking the test is the person who registered to take it (e.g., photo identification); a method for determining appropriate registration fees and collecting them; a process for identifying persons with disabilities and persons with language or reading difficulties unrelated to disabilities (e.g., speakers of English as a second language) who will need accommodations to take the test; and a means of providing those accommodations.

### 2. Test Sites and Proctors

The electronics industry sorely needs both qualified technicians and help in identifying who they are. It is to the industry's advantage to certify qualified technicians as quickly as possible. Thus, a network of test sites will be developed or an existing network (e.g., under contract with a testing service) will be utilized to make it convenient for technicians to take the exam. Test sites will be selected to minimize the need for long-distance travel or an overnight stay away from home. The system will build in the flexibility to add new test sites where and as they are needed. Many certifying organizations use hotel conference facilities and ballrooms or school classrooms and auditoriums as test sites, and the program will investigate this option. Such temporary sites provide flexibility and cost economies and work well as long as security needs can be met. Test scheduling also will be designed for the convenience of examinees, with tests given during evening hours or on weekends to minimize time off from work. Consideration also will be given to computer-based testing that would be available to examinees at any time and location.

Experienced proctors will monitor the examinations, answering procedural questions and watching for possible cheating. They most likely will be retained through a professional testing service or similar resource organization and will be hired on a temporary basis for each administration of the exam. So that they cannot inadvertently help test takers with specific questions, proctors unfamiliar with the test material and subject matter will be selected. On the other hand, proctors will be given training in any computer-based simulations to be used in the exam so that they can demonstrate the process and answer process-related questions for examinees.

### 3. Test Guides and Other Preparation Strategies

Certification test scores should accurately reflect examinees' technical skills, abilities, and grasp of fundamentals, rather than any differences in their familiarity with testing formats or procedures. Thus, test preparation materials will be developed and distributed to

registrants and through education and training programs. Overview materials will describe the test administration process, including security procedures at the test site, rest breaks, required or provided materials (e.g., scratch paper, pencils), etc. They will describe the test sections, including the number of questions in each, and explain the objective of each section. A study guide will provide sample questions of the types to be used for each test section and explain proven ways to read, think about, and respond to them. It will describe the simulation section and explain how the examinee will conduct the simulations. An optional resource reference to available study materials may be developed and offered at a reasonable fee to help candidate technicians prepare for the exam. Its sale would offset some costs of administering the program. These materials will provide as complete information as possible to help test takers prepare for the exam and to help them visualize the process so as to reduce pre-test anxiety.

Serious consideration will be given to providing training session for registered examinees prior to testing to teach them how to perform any computer-based simulations that will be used in the exam.

### 4. Scoring

Pass/fail levels will be set for the initial set of test forms after the first administration. Subsequently, pass/fail levels will be set to equate each new exam with previously administered tests. Moreover, within a single test administration, the test results from each of the several test forms will be normalized across the various test versions. Experienced test developers know how to set up test versions to simplify normalization and assure that all test takers' scores are comparable regardless of the test version taken.

Once tests are scored and equated, the examinees will be notified of their individual and overall pass/fail scores and certificates will be issued to those who have passed. Test scores, demographics, and other pertinent information will be forwarded to the data base manager for input and storage. The industry has said that it wants a list of certified technicians. The program will decide whether and in what ways the names of successful examinees will be released and/or disseminated and about the release of information upon the request of certified technicians. Regardless of process, test results (scores) will be released only upon the written request or approval of individuals who took the test and only to people they specifically identify. Test results will never be released over the telephone. Every release will be documented in writing.

Schools will be interested in the scores of their students as a measure of the value of their training programs. Schools requesting information will be given an averaged combined score for their students, *if* five or more of their students took the exam during a single administration. A combined score could reveal the averaged percentage score for all students from the requesting school on each of the technical sections and for each of the two overall exams; the students' composite pass/fail score for the six subsections and the two tests; the

number of students taking the exam and passing the exam; or the percentage of students passing. No information about individual students will be provided.

Any information released and any presentation of scores will make clear that passage of the test and subsequent certification carries specific and limited value: It attests that on the day noted the individual thus certified successfully demonstrated technical skills and knowledge based on the national skill standards for entry-level, work-ready electronics technicians; that all reasonable efforts were made to assure that the person named on the certificate is the person who took the test; and that the test was given under controlled conditions. Certification cannot be assumed to mean other than that nor to be useful in any other context.

### 5. Security of the Test and Test Results

Security measures to protect the integrity of the test will begin at the question writing sessions to develop the bank of test questions. Participants will be admonished not to discuss or otherwise disclose any body of information developed during this process. All resource materials, any notes taken, and any other written materials will be collected by the session leader at the end of each meeting and at the completion of the question writing exercise. The project manager and the contractor will institute strict controls and utilize locked files and facilities and secured computer data bases to safeguard all test question materials during their development. Access to the materials used and produced by the test writing groups and to the draft questions themselves will be limited to those responsible for development of the certification test forms. Tests and testing procedures used during the validation process will be subjected to the same security measures as the validated final bank of questions, final test forms, and administrations of actual tests.

Access to the test question bank will be limited to those with a legitimate reason for access as determined by the project manager. The project will consider encrypting the test question bank to protect against accidental compromise and access by computer hackers.

Measures successfully employed currently by testing organizations will be instituted to assure that administration of the test is not compromised by removal of a test booklet from the site or by the copying of questions during test administration. For example, to assist in tracking individual test forms, each test copy will be individually numbered; proctors will match test number and examinee as tests are given out and collected. Test takers will be allowed to take only writing implements and pocket calculators into the test area. Their portfolios, attache cases, purses, backpacks,.etc., will be stored in a controlled location away from the test area, and test takers will be denied access to them during the test.

The section on development of the bank of test questions noted that three to five questions will be developed for each question to be used in any single test. This is done for security purposes. Multiple forms of each test will be developed and used at each test site, making it useless for one test taker to copy from another. Also, different test forms will be used from one administration of the test to another to reduce the value of tests or test answers circulated among technicians in spite of security controls. (People with outstanding short-term memories have made significant money selling testing information without any overt "cheating" or removal of test documents from the site.)

### C. DATA MANAGEMENT

Like any business with employees, products, and income, the certification program will need to maintain and protect its personnel records, financial records, and data related to social security, unemployment insurance, taxes, etc. A support staff will handle these administrative functions. The critical management issues, however, relate to the storage, protection, retrieval, and use of data relating directly to administration of the certification tests: the test question bank; test forms; test registration data, including demographics about test takers; individual test scores; and various crossed-match data sets providing profiles of various categories of test takers and certified technicians. The project will establish appropriate databases as well as policies for the maintenance and security of these records. Issues of data management relating to scoring and security already have been covered. The data also will be coded and stored in a manner reflecting its possible future interest to researchers. That is, individuals may be interested in analyzing the educational or training background of examinees who pass vs. those who fail; age or geographic comparisons of successful vs. unsuccessful examinees; work experience before testing; or the benefits of certification over short and long-term employment, etc.

### D. PROGRAM MANAGEMENT

Once the bank of test questions and the test forms have been developed, EIF and EIA will make decisions regarding management of the program. Based on the literature review and assessment of current certification and accreditation programs, several options exist: The test can be managed by an existing industry organization, for example EIA; a new test management organization can be established independent of existing organizations; or an existing organization, independent of the industry trade and service organizations, can assume management of the program in order to reduce implementation time and management costs. If the last option is chosen, that organization (most likely EIF) can hire staff to operate the program; contract with an existing independent testing company to manage the program while it provides oversight and guidance; or manage parts of the program but make the bank of test questions and test forms available to test administration services or other industry organizations for administration of the test under a fee-sharing arrangement.

Industry has stated that management of a certification program by EIA or EIF would provide credibility and assure the integrity of the test; studies show management by an independent organization, such as a foundation, assures the industry that no single sector is being favored over another. Contracting with an existing testing organization for *administration* of the test (registration and onsite operation), instantly provides access to an established administrative framework, staff, procedures and policies and limits direct costs to personnel costs for the program director, data base manager, marketing specialist and clerical staff and to marketing expenses.

## III. MARKETING THE CERTIFICATION TESTING PROGRAM

As critical as the structural process is, marketing ultimately will be the key to the program's success. Certification and use of the test results are voluntary. The quality of the test will matter only if certain marketing goals are met.

- The national skill standards are broadly recognized as the industry's definitive statement of its requirements;
- The skill standards-based certification program becomes widely known and is recognized as a reliable measure of standards-based competency;
- Employers view certification as a reliable measure of an individual technician's specific strengths and weaknesses and a valuable tool in hiring;
- New technicians view certification as a significant edge in obtaining employment and seek to become certified; and
- Technical and vocational educators view the ability of their graduates to become certified as a valid measure of the school's success in providing meaningful training based on the skill standards. They teach with certification in mind (i.e., to the skill standards) and encourage their graduates to seek certification.

As stated by Eric Rice in a draft to *Marketing Guidelines to the Project Evaluation Guide*, a supplement to the Aguire International evaluation of Department of Labor skill standards project:

> "It [marketing] is critical to create an awareness of the opportunity associated with the use of the standards; critical to the acceptance of the standards within the broader community; critical to the promulgation and widespread use, including the portability of standards across the country; and critical to the sustainability and renewal of a standards system within any given industry."

Because no government regulations or industry requirements force industry or education to use the skill standards in course preparation or training or to use certification as a yardstick in hiring or a measure of success in training, any marketing program will have to sell convincingly the benefits, advantages, and opportunities associated with standards-based certification.

The framework and techniques employed by that marketing program will depend upon the actual certification program that is developed and the management options selected. Thus, at this point it is sufficient to point out that marketing will play a key role in the success or failure of the certification program regardless of the validity of the certification exam and will require a significant measure of creative thinking and a substantial investment of funding, particularly in the early years of the certification program.